

CLAIMS

1. An oxide phosphor in particulate form, wherein
5 each particle has a surface region including a vicinity thereof modified so that an elemental composition of the surface region is in a more oxidized state than an elemental composition of an internal region of the particle.
- 10 2. The oxide phosphor of Claim 1, having an elemental composition that includes a luminescent center metal able to have a plurality of valence states, wherein
the luminescent center metal in the surface region has a higher average valence as compared to the internal region.
- 15 3. The oxide phosphor of Claim 2, being an alkaline earth metal aluminate phosphor including europium as a luminescent center, wherein
europium in the surface region has a higher average
20 valence as compared to the internal region.
4. The oxide phosphor of Claim 3, wherein
in each of the plurality of particles, the elemental composition is substantially $\text{Ba}_{1-x}\text{Sr}_y\text{Eu}_z\text{MgAl}_{10}\text{O}_{17}$, where 0.05
25 $\leq x \leq 0.40$, $0 \leq y \leq 0.25$, $0.05 \leq z \leq 0.30$, and $x-y \leq z$ for

the particle as a whole,

in the particle as a whole, divalent europium accounts for no less than 60% but no more than 95% of all europium, and

5 in the surface region, divalent europium accounts for no less than 5% but no more than 30% of all europium.

5. An oxide phosphor in particulate form, wherein each particle has a surface region including a vicinity
10 thereof modified so that an elemental composition of the surface region includes more halogen or chalcogen than an elemental composition of an internal region of the particle.

6. The oxide phosphor of Claim 5, wherein
15 halogen atoms or chalcogen atoms are chemically bound to the surface region.

7. The oxide phosphor of Claim 6, wherein
fluorine atoms are chemically bound to the surface
20 region.

8. A light-emitting element having one or more phosphor layers made of an oxide phosphor recited in one of Claims 1 and 5.

9. The light-emitting element of Claim 8, wherein
within each of the phosphor layers, the oxide phosphor
recited in one of Claims 1 and 5 is disproportionally
distributed, with more at and near a surface thereof than
5 in an inner region.

10. A plasma display panel having one or more phosphor
layers composed of an oxide phosphor recited in one of Claims
1 and 5.

11. A mercury-free lamp having a phosphor layer made of
an oxide phosphor recited in one of Claims 1 and 5.

12. A phosphor treatment method, comprising a step of:
15 selectively modifying a surface region, including a
vicinity thereof, of individual phosphor particles that
constitute a phosphor by (i) forming a highly reactive gas
atmosphere by exciting gas that contains reactive gas, and
(ii) exposing the phosphor to the gas atmosphere.

20 13. The phosphor treatment method of Claim 12, wherein
the gas atmosphere is in a plasma state.

14. The phosphor treatment method of Claim 12, wherein
25 the gas atmosphere is formed at or close to atmospheric

pressure.

15. The phosphor treatment method of Claim 12, wherein
the gas containing the reactive gas is excited by
5 applying energy.

16. The phosphor treatment method of Claim 15, wherein
the gas containing the reactive gas is excited by
ultraviolet light.
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17. The phosphor treatment method of Claim 16, wherein
the ultraviolet light is applied to the gas containing
the reactive gas without illuminating a surface of the
phosphor.

18. The phosphor treatment method of Claim 15, wherein
the gas containing the reactive gas is excited by a
high-frequency voltage which causes the gas containing the
reactive gas to electrically discharge and thereby become
15 excited.
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19. The phosphor treatment method of Claim 15, wherein
a location at which the energy is applied to the gas
containing the reactive gas is separated from a location at
25 which the phosphor is exposed to the gas atmosphere.

20. The phosphor treatment method of Claim 12, wherein
the gas atmosphere is formed outside a treatment
vessel by (i) introducing the gas containing the reactive
5 gas into the treatment vessel, (ii) applying energy to excite
the introduced gas, and (iii) ejecting the excited gas
therefrom.

21. The phosphor treatment method of Claim 12, wherein
10 when exposed to the gas atmosphere, the phosphor is
in a heated state at a temperature of 300 °C or lower.

22. The phosphor treatment method of Claim 12, wherein
the reactive gas includes molecular oxygen, and
15 ozone or monatomic oxygen is formed by exciting the
reactive gas.

23. The phosphor treatment method of Claim 12, wherein
the reactive gas includes fluorinated gas.

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24. The phosphor treatment method of Claim 12, wherein
a plurality of kinds of phosphors are processed, and
a setting of one of a parameter relating to forming
the gas atmosphere and a parameter relating to exposing the
25 phosphors to the gas atmosphere is altered for each kind of

the phosphors.

25. The phosphor treatment method of Claim 12, wherein
the gas containing the reactive gas includes rare gas
5 or inert gas.

26. A method for manufacturing a light-emitting element,
comprising a step of:

modifying, within each of one or more phosphor layers
10 formed on a substrate, a region at and near a surface thereof
by (i) forming a highly reactive gas atmosphere by exciting
gas that contains reactive gas, and (ii) exposing the
substrate to the gas atmosphere.